Goddard Space Flight Center

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GSFC

Measurement & Analysis for ISD Software Projects

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Software Process Improvement (SPI) Project

Objectives

- **Purpose - Provide an overview of a software project's approach to and requirements for measurement.**

- **Objectives -- After this class you should know**
  - **A software project's measurement responsibilities**
  - **How to plan software project measurement**
  - **How to analyze and use data during project**
  - **Where to find information on measurement**

Agenda

- **Setting the stage: why measure?**
- **Measurement for software projects**
  - Key measurement activities
  - Using measures to monitor & correct project
  - Specifying measures for a project
  - ISD measurement support
- **Summary**

Why Measure?

- **Managing projects**
  - **Compare actual results with plans and expectations**
- **Understanding process**
  - **Create models of typical projects; for example what percentage of effort is needed for test?**
- **Guiding Improvement**
  - **Introduce new process or technology and assess impact on project results**

http://software.gsfc.nasa.gov/process.cfm

WAAHHH!! I don't WANT to measure!

Understandable when measurement is done badly

- **More than 90% of software measurement programs (in US) fail**
  - **Reported in "IEEE Software' 1995 (Capers Jones); 2001 (Stan Rifkin)**
    - Based on number of programs initiated vs. number active 2 years later

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WAAHHH!! I STILL don't WANT to measure!

Really? Do you…

- Track staff effort against plan?
- Watch to see if you are closing discrepancy reports (DCRs) faster than you open them?
- Pay attention to how many TBDs are left in the requirements?
- Assess whether all the capabilities planned for a build are actually delivered?

NEWS FLASH! YOU ARE MEASURING!

Project Measurement Responsibilities

- **Use measurement data to plan, track, and correct project**
  - **For the benefit of your current project**
- **Provide measurement data to ISD Measurement Team for cross-project analysis**
  - **To make managing future projects easier**
- **Comply with NPR 7150.2 & CMMI measurement requirements**
  - **Mostly overlaps with first two requirements**

Who is required to measure?

- NPR 7150.2 requires measurement for Class A,B,C,F & G
- Most GSFC mission software is Class B or C
  - Class B -- non-human space-rated software
  - Class C -- mission support software
- In addition, all ISD projects of greater than 5 staff years are required to measure
  - Use effort estimate at project start

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Measurement Activities Overview

- At start of project
  - Plan a useful measurement approach
  - Put it in the Software Management Plan (SMP)
- During a project
  - Collect & store measures
  - Use measures to monitor project and inform any needed corrections
  - Report measures at Branch Status Reviews (BSR) and milestone reviews
  - Provide cross-project data to Measurement Team

ISD Measurement Team Services

- **Products available via Web site**
  - http://software.gsfc.nasa.gov/MeasProj.htm
  - "Help desk" support for these products
- **Consulting services**
  - Oriented towards helping projects set up and run their measurement program
  - These services are *offered*, not mandated
- **Setting up ISD-level data collection**

Measurement Activities: Project Startup

- Produce an initial cost and schedule estimate
  - Includes “basis of estimate”
- Contact ISD Measurement Team to discuss measurement issues
- Plan measurement approach and document it in the Software Management Plan.
- Set up project measurement collection and storage procedures

Measurement Activities: Planning

- **Measurement content in SMP**
  - **Measurement objectives**
  - **Specific measures**
  - **Collection & storage**
  - **Analysis of measures**

    SEE DETAILS IN SMP TEMPLATES
- **Key activities**
  - **Select measures for your project**
    - Tailor standard set of measures
  - **Fill in templates in SMP**
    - Can reference ISD documentation

Measurement Activities: Collection & Storage

- ***Document the following in your SMP***
  - ***Collection*: Define (simple) procedures**
    - Who gives what data to who?
    - How frequently is it collected?
    - How is it entered? Who enters it?
  - ***Storage*: Tools often store what you need**
    - Discrepancy & Change Reporting
    - Earned Value / Point Counting
    - Requirements tool
    - Microsoft Project or Excel equivalent

Measurement activities during project

- Collect & store data
  - according to your plan
- Analyze Data to monitor & correct project
- Re-estimate periodically
  - At key milestones
  - If replan becomes necessary
- Report using Branch Status Report template
- Present status and estimates at milestones
  - See review templates
  - Also provide ISD milestone data

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Analysis and reporting

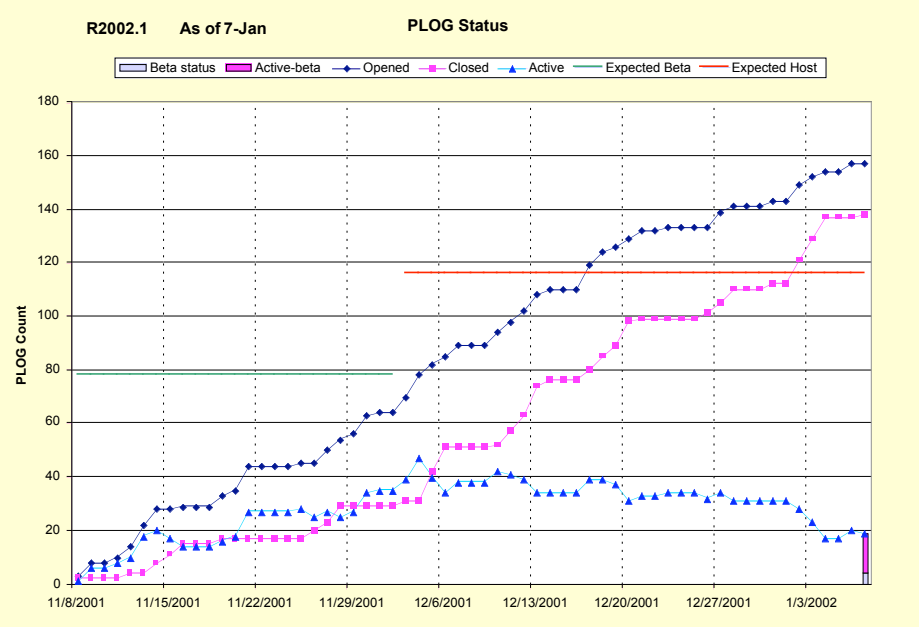
- Key data
  - Defects
  - Progress & staffing
  - Requirements changes
  - Process execution

- Sources of graphs:
  - BSR review template
  - Other examples from projects

Using Measures to Manage: Analyzing defect data

Reading the graph

- Cumulative counts: # of reports opened, number closed
- Difference these to plot # currently active
- Baseline expectations for beta and final versions

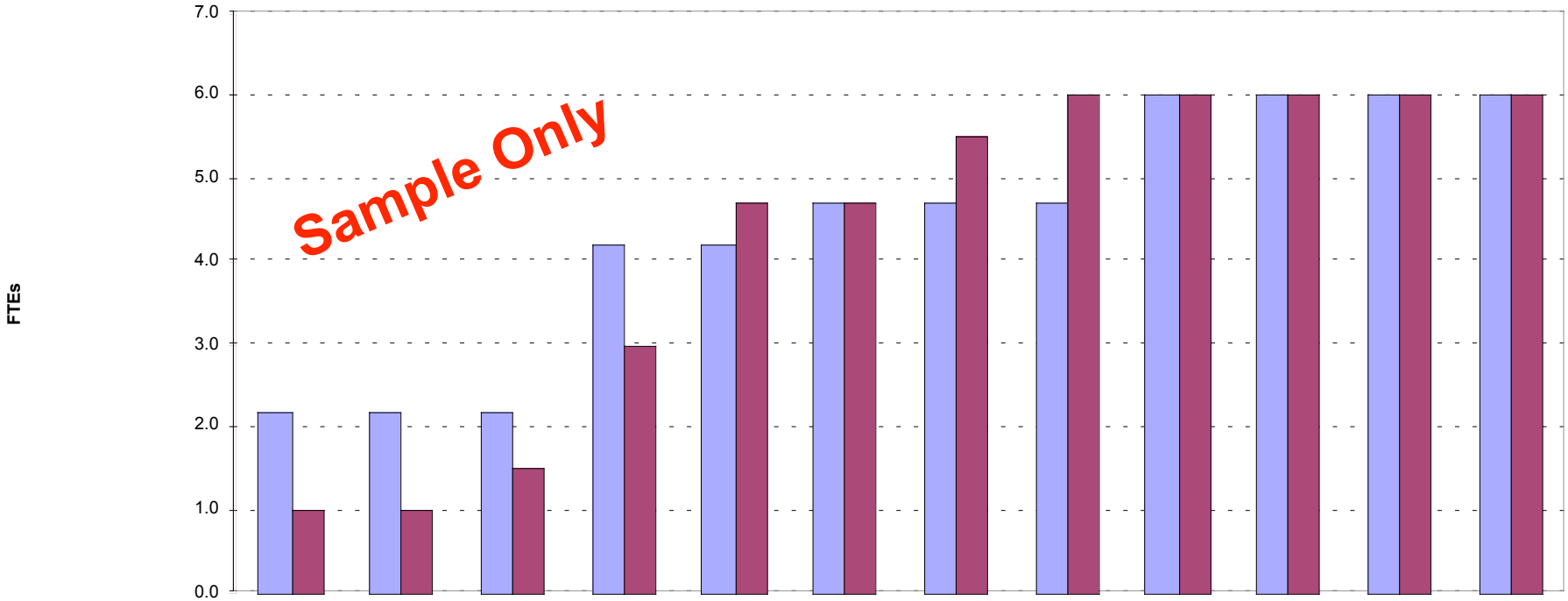


Analysis:

- Opening & closing at about the same rate until near end -- neither gaining nor losing ground
- More than expected number of reports

Staffing Summary

Monthly Planned vs Actual / Projected Staffing (FTEs)

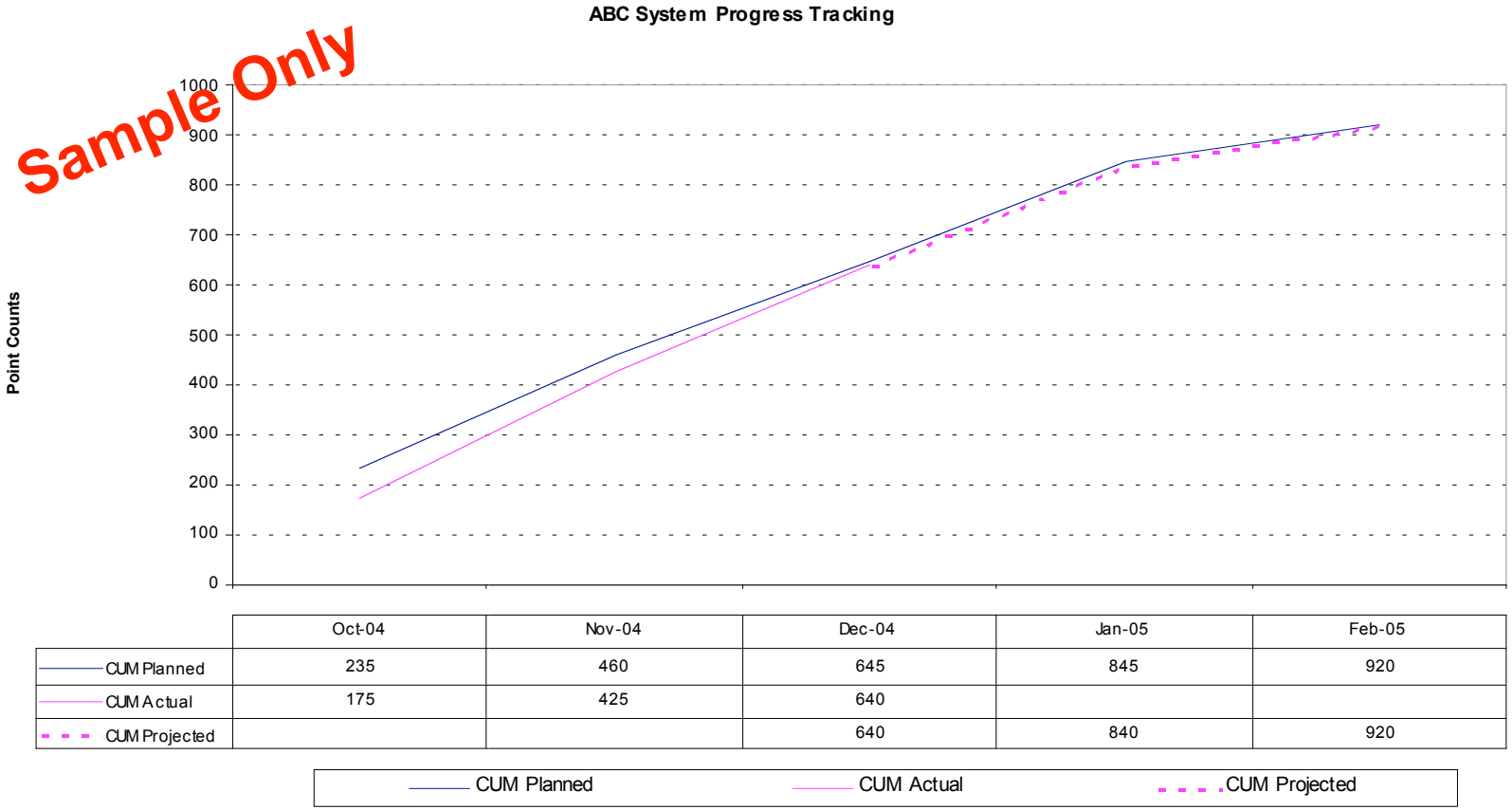


	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05
Mo Planned	2.2	2.2	2.2	4.2	4.2	4.7	4.7	4.7	6.0	6.0	6.0	6.0
Mo Actual/Projected	1.0	1.0	1.5	3.0	4.7	4.7	5.5	6.0	6.0	6.0	6.0	6.0

Staffing Status :

Project was under-staffed for the first 4 months; additional staff has been identified and will be added to the team earlier than originally planned.

BSR Guidance:
Sample Progress Tracking Metrics Chart

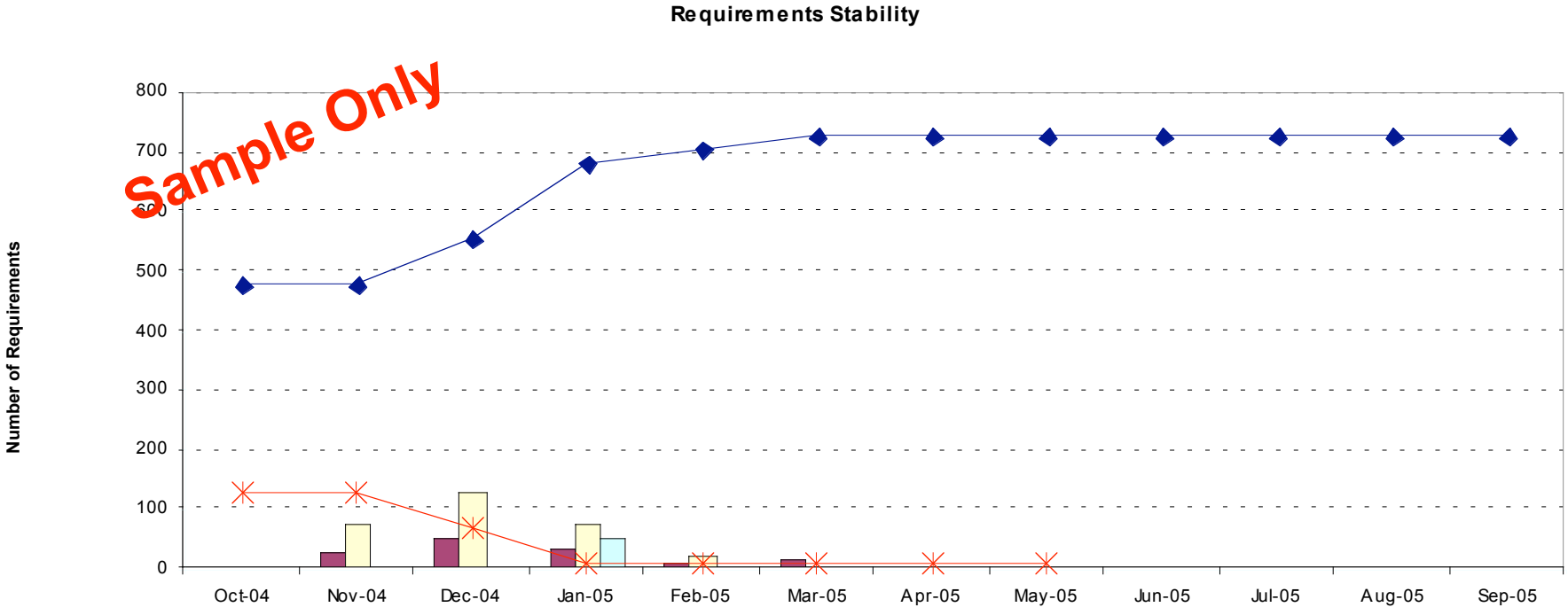


	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05
CUM Planned	235	460	645	845	920
CUM Actual	175	425	640		
CUM Projected			640	840	920

ABC System Development Status:

- **No problems encountered to date. We expect to complete Build 1 of this CSCI as scheduled at the end of February.**
- **Point count plans for Build 2 will also be presented at the next BSR.**

BSR Guidance:
Sample Requirements Volatility Metrics Chart



	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05
Changes	0	27	53	37	8	16	0	0				
Additions	0	78	127	78	22	0	0	0				
Deletions	0	0	0	53	0	0	0	0				
Baseline	475	475	553	680	705	727	727	727	727	727	727	727
TBDs	125	125	66	10	5	5	5	5				

Requirements Volatility Status:

- **Requirements have begun to stabilize since the SRR in February. We are continuing to work with the Project to resolve the remaining 5 TBDs before the PDR in August, one of which could cause significant impact.**

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Specifying Measures: Measurement areas

- 5 key areas defined by NPR 7150.2,
  - Progress and cost
  - Functionality
  - Quality
  - Requirements Volatility
  - Software characteristics
  - *Class B & F projects track for each CSCI*
- CMMI required measurement
  - Monitoring 7 Maturity Level 2 processes

Specifying measures: metrics overview table

Measurement Area	Measurement Objective *[Sample objectives are listed below.]*	Analysis	Measure(s) (Asterisk (*) indicates measure is required by the ISD Measurement Program.)	Tailoring Guidance
Software progress and cost tracking	Ensure project schedule is within 10% of the planned schedule.	Compare planned vs. actual schedule; analyze deviations.	*Event dates (planned and actual) (NOTE: Collect both milestone dates and process event dates.)	Standard set of milestones is project start, SRR, PDR, CDR, start of test, end of test, and delivery to maintenance team. Projects may combine milestones; e.g. small projects may have only one design review -- or track more than the standard ISD set.
	Ensure product progress is within 10% of planned progress.	Compare planned progress points vs. actual progress points.	*Progress tracking points (planned and actual)	
	Ensure project effort and costs remain within 10% of budget.	Compare planned vs. actual effort.	a) *Total Effort (planned and actual FTEs for civil servants and contractors)	
		Compare planned vs. actual costs.	b) Effort by CSCI (planned and actual) c) Facility and equipment costs (planned and actual)	

Objectives: Define why one is measuring

Analysis: What do you do with the data?

Measures: Name the specific data item

Tailoring: Describes options for adapting measures for your project

Specifying Measures: Progress & Cost

- **Measures**
  - **Planned & actual event dates**
  - **Planned & actual progress tracking points**
  - **Planned & actual budget and staff effort**
  - **Facility & equipment costs**
- **Tailoring**
  - **Milestone dates, progress and staff effort are minimal requirement**
    - Can combine milestones for small projects
  - **Class B & C need added "process events"**

Specifying Measures: Functionality

- **Measures**
  - Number of requirements in each release or build -- planned and delivered
  - Planned and actual memory utilization for each CSCI
- **Tailoring**
  - You are required to use at least one measure of functionality

Specifying Measures: Quality

- **Measures**
  - Number of defects by severity
  - Open and closed defects by severity
  - Length of time open by severity
  - Number of open or closed DCRs by time open

- **Tailoring**
  - Counts of defects by severity are required
  - Recommend at least one measure of timely action

Specifying Measures: Requirements Volatility

- **Measures**
  - **Number of requirements changes**
    - Total changes is sum of additions, deletions and modifications
  - **Number of requirements TBDs**

- **Tailoring**
  - **Required to track totals for both measures**
  - **Must track at least one measure by CSCI**

Specifying Measures: Software characteristics

- **Measures**
  - **For project -- name and software type**
    - Type can be flight, ground, analysis/research, infrastructure, other
  - **For each CSCI**
    - Name, primary language, COTS/MOTS/GOTS used, platform (hardware & OS)
    - Final size and units used to measure size
- **Tailoring**
  - **none**

CMMI measures

- **The ideal case for assessors is to track effort for each process area**
- **Next best thing:**
  - **Planned and actual dates of "process events" (intermediate steps in development process)**
    - e.g. "defined the WBS" for project planning
  - **Assessment of whether resources are sufficient to carry out these steps**
  - **select a useful set of events from next 2 slides**
- **CMMI gives more examples**

BSR Guidance: Sample Support Activities/Milestones (1 of 2)

As appropriate for the reporting period, address support activities and milestones such as those listed in the boxes on this and the next slide.

Project Planning

- Defined the WBS
- Estimated project costs
- Established project schedules
- Selected and documented the project life cycle
- Identified project risks
- Planned the budget against the schedule

Supplier Agreement Monitoring

- Determined type of acquisition
- Selected suppliers
- Established / maintained supplier agreements
- Reviewed candidate COTS products
- Worked with the supplier as specified in the supplier agreement
- Accepted acquired products
- Transitions acquired products to the project

Project Monitoring & Control

- Collected and tracked project progress
- Held regular monitoring meetings
- Prepared for and presented milestone reviews
- Monitored stakeholder involvement
- Presented issues to management
- Monitored and actively managed risks
- Tracked data management
- Obtained and tracked commitments

Process and Product Quality Assurance

- Negotiated software assurance support with Code 300
- Reviewed Software Assurance Plan
- Conducted process audits
- Conducted product audits
- Recorded non-compliance process / product issues
- Resolved non-compliance process / product issues

BSR Guidance: Sample Support Activities/Milestones (2 of 2)

As appropriate for the reporting period, address support activities and milestones such as those listed in the boxes on this and the previous slide.

Measurement and Analysis

- Defined, planned, and documented project measurement approach
- Obtained approval on measurement approach
- Defined project measures
- Established measurement collection repository
- Collected measures
- Analyzed and reported measures

Requirements Management

- Obtained requisite commitments to requirements
- Developed and updated bi-directional traceability matrix
- Identified and resolved inconsistencies in requirements

Configuration Management

- Defined, planned, and documented configuration management (CM) approach
- Obtained approval on CM approach
- Identified / documented configuration items
- Conducted CM Audits
- Held CCB Meetings
- Placed n items under CM control
- Established deliverable baseline

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ISD Collection Spreadsheet: Project Characteristics

Project Characteristics

Project Name	
Contact Name	
Contact e-mail	
Software Type	

← Flight, ground, …

CSCI Name	Class	Language(s)	COTS product(s)	Platform	Size	Units

NPR 7150.2 Classification

Final values at delivery

ISD Collection Spreadsheet: Milestone Data

Project Acronym	
Current Date	

Event:	**Start**	**SRR**	**PDR**	**CDR**	**Start Test**	**End Test**	**Maint.**
Basis of Estimate Provided (Y/N)							
Estimated and Actual Milestone Dates							
System Requirements Review							
Preliminary Design Review							
Critical Design Review							
Start of System Testing							
Acceptance Test End							
Turnover to Maintenance							
Progress points (from point counting)							
Actual at milestone							
Estimated at completion							
Effort (expressed as FTEs)							
Actual at milestone							
Estimated at completion							
Requirements Data							
Number of requirements							
Number of TBDs							
Cumulative changed requirements							
Cumulative Defects							
critical defects found							
moderate defects found							
minor defects found							

Color Coding Key

Gray fill = actual values -	
White fill = estimates -	

Summary

- **Measurement is useful when done right**
- **SPI products and services can help your project meet measurement requirements**
- **For more information**
  - **Web site**
    - http://software.gsfc.nasa.gov/MeasProj.htm
  - **Contact Mike Stark vie e-mail:**
    - michael.e.stark@nasa.gov

Acronyms

- CMMI -- Capability Maturity Model Integration
- CSCI -- Computer Software Configuration Item
- DCR -- Discrepancy/Change Report
- ISD -- Information Systems Division
- NPR -- NASA Procedural Requirements
- SPI -- Software Process Improvement
- TBD -- To Be Determined